Thesis Project Portfolio

Design of an Autothermal Blue Hydrogen Production Plant

(Technical Report)

An Actor Network Theory Analysis of the Failed California Hydrogen Highway Blueprint Plan

(STS Research Paper)

An Undergraduate Thesis

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Jonathan Paul

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Department of Chemical Engineering

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Sociotechnical Synthesis

The topics that I discuss in both my technical report and STS report are directly related in two ways: both attempt to aid in the fight against climate change, and both involve the analysis of hydrogen as a frontrunner in this fight. My technical project involves the full design and economic analysis of a blue hydrogen plant. This study provides further proof of my reasoning behind the failure of the Hydrogen Highway Blueprint Plan (HHBP). The technical project shows, not only the economic viability of hydrogen production, but also depicts a way in which hydrogen can be cleanly synthesized with minimal emissions. Thus, I will first introduce my technical project followed by a summary of the points I put forth in my STS study. I will then describe to my readers the importance of these two studies with respect to one another before presenting the two conjoined works in hopes of convincing my reader of their societal relevance.

My technical project consists of the complete design of a blue hydrogen production facility. This facility utilizes autothermal methane reforming (ATR) to produce hydrogen from natural gas with minimal external power input. This plant consists of six unit operations: an amine scrubber for natural gas sweetening; the ATR unit to convert most of the methane to hydrogen, carbon monoxide, and carbon dioxide; the water gas shift reactors to convert remaining carbon monoxide into hydrogen; a second amine scrubber for carbon dioxide separation; a compressing unit for carbon dioxide storage; and a pressure swing adsorber for hydrogen product purification to 99.99% purity. This plant produces over 600 tonnes of hydrogen per year while capturing around 95% of its total carbon dioxide emissions. Furthermore, based on our economic analysis, the yearly plant revenue will exceed $1.35 billion with a cumulative DCF (based on 20 years operation) of $4.80 billion.

My study of the California HHBP utilizes the actor network theory social framework in order to lay out an argument for its reason of failure. In this study I analyze the important components of the HHBP, which components failed to play their parts, and why these failures occurred. The current understanding of the HHBP's failure involves claims that hydrogen powered vehicles could never be a viable climate change solution; it is far too expensive and still produces huge amounts of greenhouse gasses. I propose and defend a new understanding of this failed network. Rather than due to the incompetency of hydrogen, I cite media biases and political tensions as the major contributing factors to the plan's failure while providing evidence disproving the previous claims of hydrogen's excessive costs and emissions.

In working on these two projects, I was able to develop a more thorough understanding of hydrogen power and the problems that have been causing implementational hindrances. The STS study allowed me to better understand how plant design and emissions could have a major effect on whether or not hydrogen power is publicly accepted, pushing me to aim my design more towards carbon capture and lower energy consumption (thus the use of ATR). Through the great deal of research conducted to develop a working plant design, I also gained a better understanding of the economic viability of hydrogen and its massive potential for growth in upcoming years, thus displaying just how valuable a hydrogen economy could be for both climate activists and hydrogen producers alike. In summary, each of these projects provided extremely valuable insight into the development of a hydrogen economy, depicting both how to build it and how best to begin its implementation.